Some Practical Examples of Diamond Microelectromechanical Structures (DMEMS)

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Abstract

CVD (chemically vapor deposited) diamond films can be processed similar to "conventional" semiconductor device fabrication and as such can be used to achieve diamond micro-electromechanical structures (DMEMS) also similar to, for example, silicon technology. An attractive feature of these diamond films is their ability to be an excellent dielectric (undoped, resistivity > 10^{14} ohm-cm to > 400 ^{o}C) or an interesting semiconductor/conductor (doped, resistivity ~ < 1 to 1 Kohm-cm). Even as polycrystalline / nanocrystalline films (depending on process deposition conditions), their breakdown strength (as dielectric) and power density capability are interestingly large numbers, particularly for the domain of high temperature, high power applications. Very small cantilever beams, membranes, stripes, tips, etc. can be constructed in doped and undoped diamond films and offer an array of choices in diamond with its known superior properties such as elastic modulus, high temperature semiconduction, high thermal conductivity, very low coefficient of expansion and numerous other diamond parameters. The development of nominally conventional patterning processes to manipulate the diamond films into capacitors, resistors and emitter configurations has led to an ability to create diamond based components of practical form and function, see Figure 1. Sequential microelectronic processing has been combined with CVD diamond technology to arrive at a "wafer fabrication" approach to achieve diamond pressure sensors and accelerometers that can perform in extreme conditions. The processes of membrane formation, PZR delineation, metallization deposition and interconnect patterning were executed. The metal interconnect was sequentially layered titanium/gold. This paper will review the design and behavior of the next generation DMEMS devices for extreme conditions and will describe the behavior of a diamond emission triode, Figure 2.

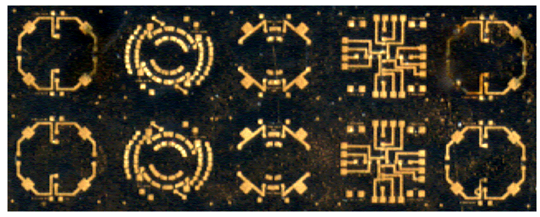
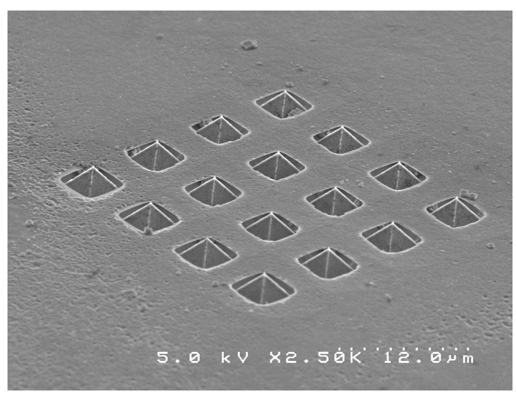
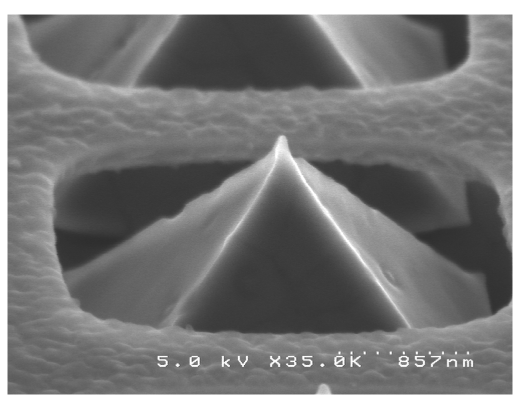


Figure 1. Optical microscope photograph of DMEMS pressure sensors monolithically fabricated on a common wafer. Each device (there are 4 different designs) is nominally 1mm across



(a)



(b)

Figure 2. SEM image of gated diamond tip emitter triode. (a) 4X4 array of tips with common gate (2,500X magnification).
(b) close up of gate and tip (35,000X magnification)